Populations of Birds on Midway and the Man-Made Factors Affecting Them

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THE BIRDS of Midway are of interest and importance for several reasons. They are of interest to professional ornithologists because of their great numbers, their ecology, and because some of them breed in no other region of the world except that of the leeward islands of Hawaii. The endemic species are of great interest *per se*. To the chance visitor to the atoll and to the men stationed there in military service the birds constitute a beneficial recreational and morale factor. Certain of the species would be of significance to a fishing industry if it were ever established in this area, since by their concentrations over schools of forage organisms they indicate to the fisherman the location of schools of marketable fish feeding on the same organisms.

Chapman (1946: 166) has emphasized recently the importance of birds to any fishing done in the area around Midway. He states,

> Fishing was done entirely, after some experience, by following the flocks of seabirds which were feeding on the same organisms as the fish. The birds were actively scouting for food all during the sunlit hours. They gathered over the spot where the fish would rise, some seconds or minutes before the fish came to the surface, in sufficient numbers that the flock could be seen for three or four miles, and they would follow a feeding school as long as it stayed at the surface. They furthermore seemed able to estimate where a school of fish would rise next with far better precision than we could, and when there were no fish in sight we formed the habit of idling the boat near a large flock of resting birds with the assurance that if they were not in the right place their scouts, which were always out, would lead them quickly to the right place before the fish rose to the surface. Fairy terns, because they were pure white and could be seen so far away, were particularly valuable in sighting distant schools as were the high flying frigate birds, but it was the mutton birds and boobies that formed the main mass of feeding birds.

With postwar expansion in Hawaiian fisheries already including French Frigate Shoal, it seems probable that the colonies of birds on islands farther to the west, Laysan, Pearl and Hermes Reef, Midway, and Kure, will become important to commercial fishermen.

In view of these facts it seems worthwhile to assemble all information relative to the trend of populations of the species inhabiting Midway Atoll and to investigate the man-made factors, past and present, that cause shifts in population numbers. This is the primary purpose of this paper. As an auxiliary objective, I wish to note the recovery of the populations since May, 1945, when a definite program of conservation was first initiated. Most of this latter information is based upon a survey which I made in late December of 1946.

I wish to express my sincere appreciation for the aid and hospitality of Captain R. W. D. Woods, Commanding Officer of Midway, during my visit in December, 1946. He arranged transportation to Midway and gave all possible assistance. I also wish to thank Commodore Gale Morgan and Commodore Gordon Rowe, successively in command at Midway prior to Captain Woods, for their genuine interest in the avifauna and their initiation of protective measures. Dr. Alexander Wetmore of the United States National Museum and Mr. Chapman Grant, who were members of the "Tanager"

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Expedition in 1922, graciously permitted me to use their unpublished estimates of the bird populations on Midway.

Since 1900 the populations of birds on Midway have been subjected to several periods of serious disturbance. Shortly after the turn of the century the atoll was twice visited by commercial plume hunters; it is likely that the island was ravaged by these hunters at least once more between 1910 and 1920. From 1920 to the late 1930's the breeding birds were not disturbed to any great extent. With the appearance of war in Europe and the threat of war in the Pacific, the islands of Midway became the site of great activity, which included vast construction projects, the stationing of thousands of men on the small islands, and, finally, the inadvertent introduction of the rat.

To discuss these major man-made disturbances or catastrophes in chronological order, the effects of the plume hunters must be considered first. We do not know how great the total numbers of each species were at the time of the slaughter or what proportion of the total population was killed. Accounts such as those of Bryan (1906, 1910), Dutcher (1905, 1907), and Henshaw (1911) indicate that hundreds of thousands of birds were killed in these forays on Midway, Laysan, Marcus, and Lisianski islands. On Laysan more than 300,000 birds were killed between May, 1909, and the fall of the same year. Over half a million were slaughtered on Lisianski. Exact figures are not known for the number killed on Midway, but several descriptions would lead one to believe that perhaps another half million birds were taken. On Marcus Island the feather hunters in 6 years practically eliminated a colony of albatrosses numbering at least one million birds. Although the Laysan and Black-footed Albatrosses were the species most desired, additional species known to have been taken in considerable numbers on Midway were: Frigate, Red-tailed Tropic Bird, Bonin Island Petrel, Christmas Island Shearwater, Wedge-tailed Shearwater, Red-footed Booby, Blue-faced Booby, Fairy Tern, Sooty Tern, Gray-backed Tern, Noddy and Hawaiian Tern, and a number of migratory species including the Golden Plover, Bristle-thighed Curlew, and the Ruddy Turnstone. On Laysan three other species were collected—the Laysan Teal, Rail, and Finch.

The effect on the populations of birds cannot be reckoned solely on the basis of the number of adults killed for their plumage. Continued depredations during any one season probably resulted in the loss of both parents of many young birds. This in turn led to the death of the young and in many instances practically eliminated the annual increment. Where the hunting lasted one year only those birds which had been at sea and had not been breeding at the time of the hunting were left to perpetuate the species. In some seabirds the number of non-breeding birds in any one season seems to be quite sufficient to form a nucleus for a colony the next year. On islands such as Marcus, where the plume hunters were undisturbed for several years, many species almost disappeared, for each year the breeding birds were killed and the increment was lost. Resident species, where present, suffered the most from continuous hunting.

Aside from natural epidemics, such as that reported by Bartsch (1922) as affecting the Sooty Terns, there was little disturbance of the nesting grounds between 1910 and the late 1930's, when the war-caused activities started. The effects of the war can best be discussed in three groups: (1) effects of construction for war; (2) effects of daily use of the breeding grounds during the war; (3) the after-effects of the war, such as the continuing adverse pressure by rats on the bird populations.

The main period of construction for war lasted more than 18 months on Midway. Thus it covered at least once the breeding season of every species on the island. Moreover, with the exception of the area around the Cable Compound, which had tall ironwood (*Casuarina*) trees, and a few small isolated areas of *Scaevola,* almost the entire surface of the two main islands

was either smoothed for roads, filled for underground installations, paved for airplane runways, or covered by stored material or buildings. Consequently, ground- and burrow-nesting species were especially hard-hit; these included the albatrosses, the shearwaters and petrels, the Noddy Tern, the Blue-faced Booby, the Red-tailed Tropic Bird, and the Laysan Rail. Also affected were the species nesting on *Scaevola* branches — Hawaiian Tern, Frigate, Laysan Finch, Red-footed Booby, and Fairy Tern.

The nesting sites were usurped and made undesirable, permanently in some instances, by the presence of these installations. The process of construction also proved detrimental. It could be expected that most of the shearwaters and petrels (and their eggs and young) would be destroyed in their burrows by the activities of bulldozers filling and smoothing nesting areas. Because construction activities went on 24 hours a day, diurnal as well as nocturnal birds were affected. Eggs and young of Sooty and Noddy Terns, Blue-faced Boobies, Tropic Birds, and Laysan Rails undoubtedly met the same fate; the adults could and probably did move out of harm's way. However, the adults of some species would not leave their eggs or young and therefore they were destroyed in one way or another. The following account (Woodbury, 1946: 149–150) indicates how the albatrosses fared during the construction period.

> The men soon tired of watching the birds but they couldn't get rid of them. Everywhere a man drove a cat or a bulldozer, the vast populations of birds stood in the way, bowing and whacking beaks or simply staring off to sea. Small gray babies nestled in little hollows made for them by their elders and refused to move out. They didn't dare, for they got roundly scolded whenever they left the nest. Washington had sent word that the goonies must not be hurt, so for a while Gallagher had to detail an extra man to walk in front of every vehicle, awkwardly requesting the birds to step aside, setting the young out of harm's way one at a time.
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> Gallagher protested that too much time was being lost; with Ventres' permission, he gave orders to run over the creatures. This didn't work any better, for the dead birds raised such a terrible smell that they had to be picked up one by one and disposed of.
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> Midway never did find a satisfactory solution to its bird problem. A year later, when the landplane runways were in, the goonies became such a serious menace to the fliers that the Navy ordered their extermination. Marines and construction men armed with two-by-fours and rods of reinforcing steel clubbed thousands to death —with almost no effect upon the population[?].

Although the work of construction never ceased entirely, the most detrimental period was just before and during the early years of the war. Despite the cessation of major construction activities the birds continued to be affected adversely by the various structures erected and by the continuous over-all use of the entire island. Fisher and Baldwin (1946: 10–13) have discussed this phase of the war's effect on the birds, but additional data and a re-evaluation of these factors seem to make a review desirable. Fences, barbed-wire entanglements on the beaches, towers, overhead wires, and poles proved to be definite hazards to albatrosses and other species. Pits, foxholes, and gun emplacements trapped albatrosses, tropic birds, shearwaters, and petrels, resulting in their death by starvation. More important than the structures that caused physical injury to individual birds was the presence of so many structures (buildings, roads, paved runways) on so much of the surface of the nesting areas. Nesting sites of all ground- and shrub-nesting species were thus usurped and the breeding potential of the birds reduced.

All movable vehicles, from bombers to jeeps, killed thousands of all avian species inhabiting the islands. Airplanes were especially detrimental to the great wheeling flocks of Sooty Terns and Red-tailed Tropic Birds. Albatrosses of both species were killed in the air, as the following account from Woodbury (1946: 374) shows: "The goonies, likewise, cared nothing for the military safety of the station. Any pilot who took off or landed on the gleaming new runways could be sure of hitting half

a dozen of them, sometimes bending a prop or cracking a windshield. Worst of all, the goonies loved to fly in groups, sitting almost motionless high in the air in a perfect battle formation that fooled many a lookout and sent the island to battle quarters more than once." At night the shearwaters and petrels were killed in the air. However, it was not only in the air that planes killed birds; in landings, in take-offs, and in moving from place to place on the ground the planes were forced to pass through flocks of birds on the runways and parkways. Sooty and Noddy Terns, Wedge-tailed Shearwaters, both albatrosses, and Bonin Island Petrels were prone to alight on the runways which no doubt covered parts of their former nesting grounds. Trucks, jeeps, and other passenger vehicles which were constantly moving about on the narrow, *Scaevola*-bordered roads ran down countless thousands of individuals of these species. Further, vehicles sometimes left the roads and traveled "cross country" through colonies of ground-nesting terns, killing young and adults and smashing eggs; or they went across areas honeycombed by the burrows of shearwaters and petrels with the same result.

The presence of so many human beings (about 15,000 at one time) on so small an area (less than 2 square miles) was also an important factor in reducing the populations. In December, 1946, less than 1,000 people were stationed at Midway, but in the future the permanent complement of military personnel may be about 3,000. Psychological disturbances to all species no doubt reduced the success of their nesting; most adversely affected were the colonies of Sooty Terns, Gray-backed Terns, and Fairy Terns. Albatrosses, Red-tailed Tropic Birds, and Red-footed Boobies seem less disturbed by the mere presence of man near the nest, but the actual effect on them is unknown. The nocturnal, burrow-nesting species were least affected, as far as psychological disturbances were concerned, but these species were the most hated by the men and consequently suffered more physical violence. The adults were killed, their young and eggs destroyed, and their burrows tramped shut. It should be noted that this persecution of shearwaters and petrels was limited for the most part to the Wedge-tailed Shearwater and the Bonin Island Petrel; Bulwer's Petrel and the Christmas Island Shearwater suffered less because of their relative scarcity and because they are limited to Eastern Island which always had fewer men stationed on it than did Sand Island. The Wedge-tailed Shearwater was also subjected to another form of human depredation—the daily gathering of eggs for food. The extent of this form of adverse pressure is unknown for Midway, but it did occur.

Wanton killing of birds (other than the "moaning birds") by military personnel during the war was probably a relatively unimportant factor in decreasing the populations, and naval authorities set up stringent, but sometimes bypassed, regulations about it.

No doubt the most serious factor brought by man was the rat, which was inadvertently introduced early in 1943. By the time control measures were initiated in 1945, it was computed on the basis of bait eaten from feeding station pans that the rat population was greater than 100 per acre. Trapping and poison baits aided in controlling the rats during 1945 and the first half of 1946 at which time the scope of the control program had to be reduced because of lack of personnel. However, the control never was complete, and since 1944 rats have exerted a depressing effect on various species. The Bonin Island Petrel, Bulwer's Petrel, and the Fairy Tern have suffered from rats. Extinction of the Laysan Finch and Laysan Rail may be attributed principally to rat depredations. The Hawaiian Tern, although it is a shrub- and tree-nesting species, has been affected. Alsatt (1945: 49–51) noted that adults of the Fairy Tern were not obviously fewer in numbers, but fewer young were seen in early 1945. Further, he found that immature birds under observation disappeared overnight. The decline in numbers of the Domestic Canary also started with the introduction of the rat.

The rat problem is a continuing one and forms an important part of the third category, the after-effects of the war on the birds. As long as men were available and as long as the military authorities had sufficient reason (other than birds) to keep the control program functioning, the rat populations were held in check. With the close of the war and the virtual abandonment (withdrawal of all personnel) of Eastern Island of Midway, the rats began to increase. In December, 1946, rats were quite in evidence on both Sand and Eastern Islands, but especially on the latter. Since the populations of Christmas Island Shearwaters and of Bulwer's Petrels are small, and since at Midway they occur only on Eastern Island, they are in real danger of elimination. It seems probable that on Sand Island some sort of control program will always be in effect, but it is doubtful whether the numbers of rats will be reduced sufficiently to stop their depredations on birds.

Other lasting effects of the war include the effects of acres of pavement put down for runways over the central parts of both islands. This pavement, as indicated earlier, covers the most heavily used breeding grounds of the Laysan Albatross, Wedge-tailed Shearwater, Bonin Island Petrel, Red-tailed Tropic Bird, and Sooty Tern. The area is lost for breeding activities. Macadam roads produce the same effect. It is true that Noddy Terns, albatrosses, shearwaters, and petrels have already moved back to the shoulders of the runways. Little-used coral roads through the *Scaevola* are being reclaimed as nesting areas by both species of albatrosses, but these nesting birds are liable to destruction by any passing vehicle. Many gun pits, foxholes, and other traps have been filled in, but some will no doubt remain for years. Buildings still cover many former nesting sites. However, for the most part the buildings are temporary and will simply disintegrate if they are not removed. Both species of albatrosses are now nesting in and around such buildings.

In addition to factors which have worked to the detriment of the birds there have been a few, man-made, beneficial factors. Before the establishment of the Cable Station there was not much vegetation on Sand Island, and Eastern Island was called Green Island. The reverse is true now, due chiefly to the early (about 1906) activities of the employees of the Commercial Cable Company in planting ironwood trees, a coarse grass (*Ammophila arenaria*), and many other exotic plants on Sand Island. A nursery was established to provide further plantings. Pan American Airways aided in the work of planting Sand Island. The United States Navy planted sand-stabilizing grasses, as well as ironwood trees, sea grape (*Coccoloba*), and tree heliotrope (*Messerschmidia*). Most of these plantings are taking hold well and in time those of the last 6 years will replace much of the cover that was destroyed early in the war.

The effect of a greater amount of plant growth on birds is variable from species to species. There is little doubt that the presence of ironwood trees which provide many safe nesting places has increased the populations of Fairy and Hawaiian Terns. Bryan (1906), who visited Sand Island in July and August, 1902, found only 12 to 20 Hawaiian Terns, and long-time employees of the cable company say that Fairy Terns are much more numerous than they were 20 years ago. During the height of the depredations by rats the Domestic Canaries took refuge in the ironwood trees for safer nesting. These trees are also used by the Domestic Pigeons, which are becoming numerous. The last holdout of the Laysan Finch was in the ironwood trees and hibiscus hedges planted by the employees of the cable company. The Laysan Rail apparently made its last stand in the area around the exotic shrubs and lawns. This may, however, have been the result of better rat control in this area, rather than any particular advantages offered the rail by the habitat there.

Perhaps the only species that would not benefit, and might be harmed, by additional trees and shrubs are the Laysan and Black-footed Albatrosses and the Blue-faced Booby, all of which need strips of open area for landing and

for taking off. The albatrosses, despite the fact that they nest beneath clumps of shrubs, do not alight in the midst of the bushes; they always walk in to the nest from the nearest open space, although in some instances this distance is more than 100 feet. The widely spaced plantings of ironwood trees do not seem to reduce the number of Laysan Albatrosses nesting beneath them, perhaps because there is room to fly between the trunks and because the plantings are interspersed with roads, building areas, and other open spaces. However, if a great part of the surface were covered with dense, low-growing shrubs I think the number of Laysan Albatrosses would be reduced. Certainly the beach-loving Black-footed Albatrosses would not, under such conditions, invade the central areas of the islands as they now do. The Sooty and Gray-backed Terns might also be affected by more plant growth; on Midway, colonies of these birds seem to center in open spaces and simply overlap adjoining *Scaevola*-covered areas.

To establish successfully many of the exotic plants it was necessary to bring in soil. After 1906 the cable company brought in the equivalent of several shiploads (about 9,000 tons) of soil to get trees, shrubs, and grasses started around its compound. Later, soil was brought in to develop the nursery. The maintenance of a small farm with a few cows and chickens has added to the fertility of Sand Island. Not only has this soil been beneficial in producing a plant growth; it has also provided a topsoil better adapted to the needs of burrowing birds. It is not uncommon to see the burrows of petrels and shearwaters and the nests of albatrosses filled and covered by blowing sand in areas where there is neither humus nor plant roots to hold the sand. Burrows in pure sand collapse easily, trapping the birds; entrances to burrows of Bonin Island Petrels here are sometimes cone-shaped, 5 feet in diameter and 3 feet deep, caused by the constant sifting down and collapsing of the dry sand. It may be observed that where possible the birds select partly vegetated areas for burrowing.

Another act of man that will in the future help the birds is the addition to the area of the islands by filling with material dredged from the reef. Many acres of land have been created in this manner. At present only a few Laysan and Black-footed Albatrosses are using this new area which is barren of vegetation and has no topsoil. Further, it will take some time for the birds to extend their breeding areas to encompass this new region. Judging from other areas occupied by the various species the first forms to utilize this coral fill will be the albatrosses, Sooty Terns, and perhaps the Blue-faced Booby. As soon as low grasses appear the Noddy Terns and Gray-backed Terns will move in as they have already done on other parts of the island which have been reclaimed from war use. The Fairy Tern, Hawaiian Tern, and Red-footed Booby will not utilize the area until the *Scaevola* gets a good growth, nor will the Red-tailed Tropic Bird, which is a ground nester but is usually found beneath the *Scaevola.* It also is unlikely that Bulwer's Petrel and the Christmas Island Shearwater will nest on this hard-packed, smooth fill until some shrubs or piles of coral provide cover.

There are few reliable figures on the avian populations of Midway. Scattered notes on numbers of individuals of various species are to be found, but it was not until the "Tanager" Expedition visited Midway in April, 1922, that any attempt was made to secure data on the populations of all species inhabiting the atoll. In the period 1922 to 1941 no papers of any kind were published on the birds of Midway. Hadden (1941) gives incomplete estimates of some populations based on observations over a period of at least a year. Fisher and Baldwin (1946: 4) estimated the numbers of all species present in May, 1945; using the same method whenever possible, I took a census of all species present in December, 1946. It may be observed from this brief history that not only are there few census data available but that the data have not been secured in comparable months of the year and that no standard procedure has been

followed in estimating the populations. The results of the more extensive censuses mentioned above are presented in Table 1.

In this table the trend of populations can be observed in some species, but usually only in a general sort of way because different observers were involved and because allowances must be made for different months of the year. However, in many instances direct comparisons between the figures for 1922, 1945, and 1946 may be made. For example, the period of nesting and caring for the young in the albatrosses covers the months from November to May or June. Hence, data in any of these months can be used for comparative purposes, although one might expect that mortality from natural causes would reduce the number of adults in the latter part of the reproductive period.

The populations of both species of albatrosses, Bonin Island Petrels, Hawaiian Terns, Wedge-tailed Shearwaters, Red-tailed Tropic Birds, and Gray-backed Terns increased greatly from 1922 to 1945 despite the adverse effects of the war. Of these the first four species showed considerable gains in the 18 months between the observations of 1945 and 1946. The table would seem to indicate an increase in the numbers of Christmas Island Shearwaters, Bulwer's Petrels, and Sooty Terns, but the month's difference in census dates is important; these species are just moving into the islands in late April and early May. This may explain the relatively few Sooty Terns found by the "Tanager" Expedition in 1922 and may explain the absence of Christmas Island Shearwaters and Bulwer's Petrels in April, 1922.

Populations of Blue-faced Boobies, Red-footed Boobies, frigates, and noddies have apparently never been abundant and there has been little change in numbers in the last 25 years. Noddies were much more abundant in December, 1946, than in May, 1945; this may be due

TABLE 1

ESTIMATED NUMBERS OF BIRDS ON MIDWAY ATOLL*

	WETMORE APRIL, 1922	GRANT APRIL, 1922	FISHER, BALDWIN MAY, 1945	FISHER DEC., 1946
Black-footed Albatross	4,000 N	5,000	53,000 N	69,000 N
Laysan Albatross	5,000 N	5,000	110,000 N	145,000 N
Wedge-tailed Shearwater	common	5,000	62,000 N	0
Christmas Island Shearwater	?	0	400 N	0
Bonin Island Petrel	many N	5,000	25,000 N	30,000
Bulwer's Petrel	?	0	600 N	0
Red-tailed Tropic Bird	20	300	19,000 N	25
Blue-faced Booby	2	——	3 N	5
Red-footed Booby	50 N	500	450 N	150
Brown Booby	12	500	0	0
Frigate (Bryan, 1902, saw 60)	100 N	——	60	100
Mallard Duck	——	——	0	2
Laysan Rail	abundant	5,000	0	0
Pacific Golden Plover	many	1,000	250	2,500
Bristle-thighed Curlew	several	100	20	200
Ruddy Turnstone	common	5,000	350	9,000
Sanderling	0	0	0	2
Wandering Tattler	1	50	0	2
Gray-backed Tern	300 N	——	750 N	0
Sooty Tern	1,500	5,000	174,000 N	0
Noddy Tern	24	——	10	175 N
Hawaiian Tern (Bryan, 1902, saw 20)	few	100	2,100 N	2,500 N
Fairy Tern	fairly common	1,000	20,000 N	increasing daily
Domestic Pigeon	0	0	50 N	125 N
Domestic Canary	1,000	1,000	30 N	75 N
Laysan Finch	abundant	5,000	0	0

* N—indicates nesting on that date.

in part to a concentration for breeding in the winter, although the species nests the year round. Domestic Canaries decreased greatly in numbers from 1922 to 1945, but have since increased sharply. Domestic Pigeons transplanted sometime after 1922 are increasing rapidly. Two species, the Laysan Rail and the Laysan Finch, were abundant in 1922 and maintained this abundance until the late 1930's; rats probably accounted for the last individuals in early 1945. Brown Boobies were not seen in 1945 and 1946, but they have never been abundant on Midway.

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